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ON THE SIZE OF MICELLES IN JUTE FIBRE OF DIFFERENT QUALITIES AND OF KNOWN STRENGTH

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Plate I

ABSTRACT. The halfwidths of reflections from (002), (020) and (120) planes in the X-ray diffraction patterns due to samples of jute fibre of nine different qualities have been determined with the help of blackening-log intensity curves. The values of m_1, m_2 and m_3, which denote the number of times the unit cell is repeated in the micelle along the *a*, *b* and *c* axis respectively have been determined in each case by Laue's method. The average strengths of the fibre in the samples cut from adjacent portions of the samples used for the X-ray investigation have also been measured. It is observed that the value of m_3 is almost constant and is about nine in the case of eight of the nine samples studied, while in the remaining case it is seven. The values of m_2 vary from 7 to 12 for the different qualities of the fibre studied and these values seem to be proportional to the strength of the fibre. The values of m_1 also vary from 5 to 8 for the different varieties studied, but there seems to be no correlation between the value of m_1 and the strength of the fibre.

INTRODUCTION

The size of micelles in a few different varieties of unbleached jute fibre was first determined by Sirkar and Saha (1946), employing Laue's (Laue, 1926) method. The (020) reflections were almost masked by continuous blackening, because the slit used was not very fine, and so the reflections from (002), (031) and (120) were used for the determination of m_1, m_2 and m_3, which denote the number of times the unit cell is repeated along *a*, *b* and *c*-axis respectively. The present authors (Sirkar and Chowdhury, 1946) used narrower slits and determined the half widths of reflections from (002), (120) and (020) reflections in the case of five varieties of jute fibre, both in the raw and bleached states. The strengths of the fibres used for the X-ray investigation were not, however, known accurately, and although m_2 was determined directly from the half width of (020) reflection by Laue's method, and the value of m_2 was found to be the largest and about 15 in the case of high quality Tossa jute fibre which has generally a very large tensile strength, a general conclusion cannot be drawn from these results that the greater the value of m_2 larger is the strength of the fibre. It was, therefore, thought worthwhile to determine the value of m_1, m_2 and m_3 by the Laue's method in the case of a large number of different varieties of jute fibre of known strengths.

EXPERIMENTAL

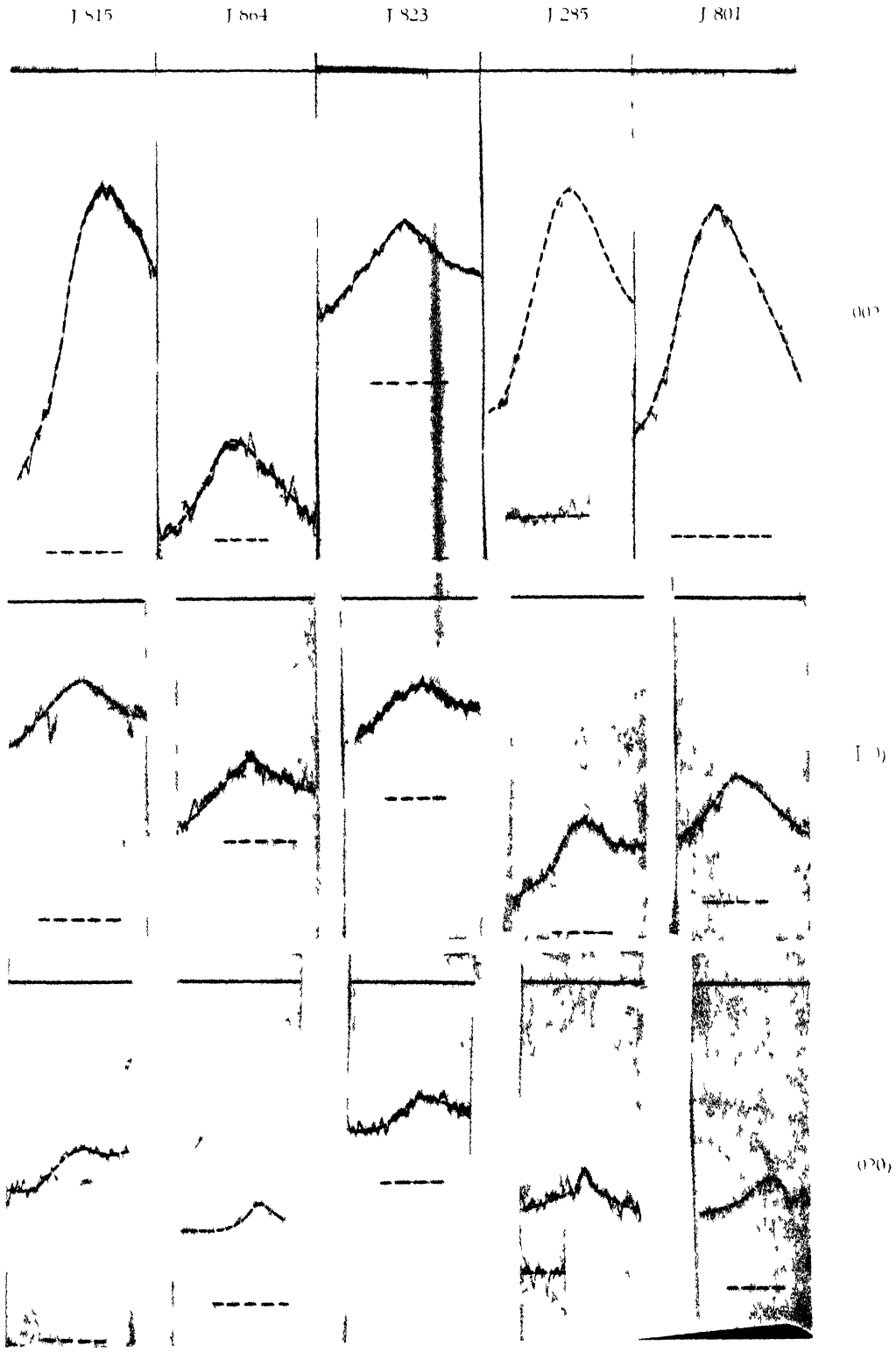
Small narrow bundles, each containing about a dozen strands of raw jute fibre of a particular trade quality were selected and two samples from adjacent portions of the length of each such bundle were cut off. One of these two samples of each quality was selected for X-ray analysis and the other was sent to the Director, Technological Research Laboratories of the Indian Central Jute Committee for the measurement of the strength of the fibre. The strengths of jute fibre of fourteen different qualities were kindly supplied by him, but the half widths of reflections from (002), (020) and (120) planes were measured in the case of only nine of these varieties. The camera used was the same as that used by the present authors previously (Sirkar and Chowdhury, 1946). In each case two photographs of the X-ray diffraction pattern were obtained, one with such a moderately short exposure that the (002) reflection was not over exposed, and the other with a longer exposure to get sufficient blackening due to the (020) reflection. It was also necessary to draw two blackening-log intensity curves, one with densities ranging from .04 up to .54 and the other from, 0.2 up to 2.2 in order to measure the half widths of the (020) and (120) reflections which are faint and of the (002) reflection which is very intense. The microphotometric records were taken with a Kipp and Zonen type self-recording microphotometer and on each record the deflections corresponding to infinite density and the unexposed portion of the film were recorded. The intensity at any point in the spot was determined by first determining the total intensity at that point and then subtracting from it the intensity of the background with respect to the unexposed portion of the film. The observed half widths on the microphotometric record were reduced to radians by taking into account the magnification in the microphotometer (seven in this case), the value of the Bragg angle for the particular reflection and the distance of the film from the irradiated sample

The values of m_3, m_2 and m_1 were then determined from the values of the half widths, of the (002), (020) and (120) reflections respectively by using the Laue's formula (Laue, 1926),

$$B\cos\frac{\chi_m}{2} = \cdot 9\lambda \left(\frac{\frac{h^2}{m_1^2a^4} + \frac{k^2}{m_2^2b^4} + \frac{l^2}{m_3^2c^4}}{\frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2}}\right)^{\frac{1}{2}}$$

where B is the halfwidth of $(h\ k\ l)$ reflection in radian and χ_m is the angle between the incident and reflected X-rays. This formula reduced to the following forms for different values of $h\ k\ l$:

$$\text{For (002)},\ m_3 = \frac{\cdot 1777}{B_3},$$



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$$\text{for } (020),\ m_2 = \frac{\cdot 1361}{B_2},$$

$$\text{and for } (120),\ \frac{B_1^2}{38\cdot 23} - 3\cdot 553 \times 10^{-4} \frac{}{m_2^2} = 2\cdot 058 \times 10^{-4} \frac{}{m_1^2}$$

where, B_1, B_2 and B_3 are the values of B for these reflections.

RESULTS AND DISCUSSION

Some of the microphotometric records from which the values of the half widths of the reflections from (120), (020) and (002) planes were determined are reproduced in Plate I. The curves were smoothed out while these half widths were determined. These smoothed curves are shown by dotted lines in ink. The results are given in Table I in the last column of which the strength of the fibre is given in terms of breaking load divided by mass per unit length.

TABLE I

Trade Quality	B_3	m_3	B_2	m_2	B_1	m_1	Strength F/M × 10^6
J 823	.022	8	.020	7	.021	7	1.89 ± .17
J 864	.020	9	.014	10	.021	5	3.9 ± .29
J 285	.020	9	.011	12	.016	7	4 55 ± 21
J 803	.020	9	.020	7	.022	6	2 15 ± 14
J 815	025	7	.019	7	024	5	2.69 ± .06
J 310	.019	9	.014	10	019	6	3.69 ± .18
J 801	.023	8	.014	10	016	8	3 26 ± .18
J 816	.020	9	.017	8	.020	6	2 92 ± .14
Chinsura green	.022	8	.019	7	.020	8	2.52 ± 09

It can be seen from Table I that except in the case of J 815, the value of m_3 is almost constant, being 8 in three cases and 9 in the remaining five cases. It is difficult to say whether the value 7 observed in the case of J 815 is due to some local defect in the film, because, no attempt has been made to repeat the experiment. The value of m_2 on the other hand varies widely from quality to quality being almost proportional to the strength expressed in terms of breaking load divided by mass per unit length and given in the last column of Table I. The values of m_1, again, varies widely from quality to quality, but there seems to be no correlation between the values of m_1 and the strength of the fibre. Thus the results seem to point to the general conclusion that the

strength of the fibre is partly determined by the length of the micelle along *b*-axis and the longer chain corresponds to the higher strength.

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